Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
Amendment of the Commission's Rules to Promote Aviation Safety	)	WT Docket No. 19-140

REPLY COMMENTS OF MOOG, INC.

Moog Inc. ("Moog"), by its attorney, hereby submits its reply to comments on the Commission's Notice of Proposed Rulemaking ("NPRM") in the above-referenced docket.[1] As with its opening comments, Moog's reply addresses the potential new allocation and service rules proposed in the *NPRM* that would permit the deployment of Enhanced Flight Vision Systems ("EFVS") in the United States in the 92.0-95.5 GHz range (the "94 GHz Band").

Moog is a manufacturer, developer, and designer of foreign object debris ("FOD") solutions that operate in the 94 GHz Band which are beginning to be deployed in the United States.[2] In its initial comments, Moog noted that discussions with Sierra Nevada Corporation ("SNC") strongly suggest that SNC's proposed EFVS could operate compatibly with Moog's Tarsier FOD system, which is already being deployed in the United States.[3] SNC, in its comments, essentially concurs, noting that "[i]t appears from preliminary discussions that there is sufficient bandwidth so that channel selection may

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1 *In the Matter of Amendment of the Commission's Rules to Promote Aviation Safety*, Notice of Proposed Rulemaking, FCC 19-53, WT Docket No. 19-140 (rel. June 7, 2019)("NPRM").

2 Comments of Moog, Inc., WT Docket No. 19-140, at 2-3 (filed Sep. 3, 2019)("Comments of Moog").

3 *Id*. at 4.

facilitate effective sharing between EFVS and FOD systems operating at the same facilities."[4] Moog is encouraged by SNC's statement that it intends to "work constructively to develop an effective spectrum sharing plan should one prove necessary."[5]

Moog looks forward to such collaborative efforts at any locations where its Tarsier system may be collocated with SNC's future EFVS systems and urges the Commission, should it adopt an allocation and service rules to support EFVS, to provide for coordination of EFVS with FOD detection systems deployed under the co-primary Radiolocation allocation that already exists in the band. Moog respectfully urges the Commission to adopt rules and take other measures to encourage EFVS system design that uses the spectrum efficiently with minimal bandwidth and numbers of channels and incorporates spectrum flexibility (for example, all certificated EFVS equipment should be

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[4] Comments of Sierra Nevada Corporation WT Docket No. 19-140, at 6 (filed Sep. 3, 2019)("Comments of SNC"). Moog explained in its opening comments that compatibility would result from channel selection by the EFVS system to avoid any collocated FOD system, which is achievable because SNC's EFVS system requires only a few one-hundred-megahertz-wide channels in order for full operations at an airport, a small fraction of the total bandwidth requested by SNC in its petition for rulemaking. *See* Comments of Moog at 4. SNC, in its comments, points to several other EFVS system characteristics that it claims would, as a general matter, "make the probability of an EFVS system causing harmful interference [to other users] extremely unlikely," such as low power, operation at low altitude, a low duty cycle, and short duration operations only in adverse environmental conditions with "sever propagation losses." Comments of SNC at 5 (explaining that EFVS "will generally be operational for less than thirty seconds over the course of less than a linear mile prior to an aircraft touching down"). Moog wishes to note that, while these factors may facilitate the ability of EVFS to share with other co-channel systems, not all of them will enhance compatibility with collocated 94 GHz FOD systems which will also be operating in the same adverse conditions as EFVS and in relatively close proximity to aircraft that may be utilizing EFVS for approaches. (Unlike EFVS, Tarsier FOD detection systems continuously operate in *all* conditions.) Rather, Moog submits, it is primarily frequency selection that will enable EFVS/FOD sharing at the same airport or airfield.

[5] Comments of SNC at 6.

capable of operating over the entire band) so as to maximize compatibility with other users.

Two commenters from the aviation sector express their support for a regulatory framework that enables operation of FOD detection systems in addition to EFVS in the 94 GHz band. The Air Line Pilots Association, International ("ALPA"), supports EFVS while also acknowledging Moog's use of the band for FOD detection, explaining that

> ALPA believes that FOD presents a real and significant hazard to aviation during taxi, takeoff, and landing operations. Since both applications [*i.e.*, EFVS and FOD detection] provide safety enhancements to airplane operations, ALPA recommends that the FOD detection community and the millimeter wave radar EFVS community work together to enable co-existence of both FOD detection radars and EFVS equipment in this band, either technically or by operational mitigations.[6]

Similarly, Aviation Spectrum Resources Inc. ("ASRI") supports the adoption of 94 GHz rules for EFVS, but urges that, in light of "current work to develop an international foreign object debris (FOD) detection system in the 92-100 GHz band, . . . additional technical work should be conducted to show how the systems would share the spectrum."[7] ASRI adds that the "benefits for aviation that should drive both proponents [meaning those of EFVS and FOD] to find a way to coexist."[8] Moog is pleased that ALPA and ASRI have recognized the value and importance of FOD detection in their comments, and it looks forward to working with these organizations along with SNC toward the ends of compatible operation.

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6 Comments of The Air Line Pilots Association, International, WT Docket No. 19-140, at 2 (filed Sep. 3, 2019).

7 Comments of Aviation Spectrum Resources, Inc., WT Docket No. 19-140, at 13 (filed Sep. 3, 2019).

8 *Id.*

The Commission, if it adopts rule changes to permit EFVS at 94 GHz, should limit such EFVS to on-board displays on manned aircraft, consistent with the SNC Petition.[9] In the NPRM, the Commission proposes to adopt the Federal Aviation Administration's ("FAA's") definition of an EFVS system, which expressly contemplates "an *installed* aircraft system which uses an electronic means to provide a display of the forward external scene topography (the natural or manmade features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging sensors, including but not limited to forward-looking infrared, millimeter wave radiometry, millimeter wave radar, or low-light level image intensification."[10] Moog has no objection to the definition, and therefore agrees with the Commission's proposal.

AiRXOS, Inc. (AiRXOS"), in its comments, seeks to expand the definition substantially – and, consequently, the EFVS field of operations substantially -- by including on-ground displays so as to allow UAS, as well as manned aircraft, to use EFVS radar frequencies to detect and avoid dangerous obstacles and terrain.[11] In short, AiRXOS proposes that the definition of EFVS should encompass displays not installed on an aircraft or limited to on-aircraft controls. The definition would also be one that applies across all frequency bands where EFVS is offered.[12] AiRXOS made no effort to

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9 Amendment of the Commission's Rules to Allow for Enhanced Flight Vision System Radar under Part 87, Petition of Sierra Nevada Corporation for Rulemaking, Docket No. RM-11799, at 4 (filed Feb. 16, 2018) ("SNC's EFVS generates terrain and obstacle imagery to supplement instrument landing systems and a pilot's natural vision during an aircraft's final approach and landing in DVEs.")

10 *NPRM*, n. 24. *See* 14 CFR § 1.1 The proposed definition also explains that "[a]n EFVS includes the display element, sensors, computers and power supplies, indications, and controls." *NPRM*, n. 24.

11 Comments of AiRXOS, Inc. WT Docket No. 19-140, at 5 (filed Sep. 3, 2019).

12 Several commenters note that EFVS is permitted in other bands or uses other technologies, and that EFVS should be considered in yet additional frequency ranges.

suggest how this broadened definition, which would, if adopted, potentially lead to a more geographically ubiquitous use of 94 GHz EVFS, would impact other services operating at 94 GHz, such as FOD detection. Further, operation of 94 GHz EFVS on UAS would ostensibly not possess many of the features that could enhance compatibility with other services, as cited by SNC in its comments.[13] It is unclear, for example, if EFVS were to be used outside of manned aircraft close approaches, whether the following factors SNC points to that enhance compatibility would be present, such as operation at low altitude with short duration, a low duty cycle, operations only in adverse environmental conditions, and frequency selection to avoid interference with local FOD systems.[14] Moog submits that the Commission should not invite an uncontrolled expansion of EFVS deployments such as AiRXOS envisions. Consideration of EFVS for unmanned aircraft *for any band* goes beyond the scope of the *NPRM*.[15] Any such consideration should first be studied and determinations regarding appropriate

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See Comments of Collins Aerospace, WT Docket No. 19-140, at 6 (filed Sep. 3, 2019); Comments of Airbus, WT Docket No. 19-140, at 4 (filed Sep. 3, 2019)(" lower frequency bands may be practical for EFVS"). Collins Aerospace, a manufacturer of EFVS systems, supports the proposal generally but disputes Sierra's claim that 94 GHz is superior to infrared EFVS technology, noting that infrared is the only technology that currently meets FAA requirements for EFVS. Comments of Collins Aerospace at 6. Collins Aerospace also explains that "numerous [EFVS] systems at other frequency bands [*i.e.*, other than 94 GHz] have been demonstrated to be both equally beneficial to the operation and fit under aircraft radomes" and suggests that the Commission, while adopting rules to permit 94 GHz EFVS, should "explore alternative frequency bands and associated changes to part 87 in the future." *Id.* at 6, 7. Consideration of other bands for EFVS would seem to be beyond the scope of this rulemaking, although there would seem to be merit to such explorations.

13 *See* Comments of SNC at 5.

14 *See id.*at 5, 6.

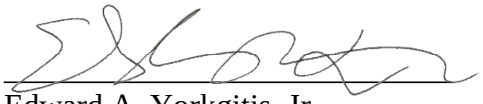
15 AiRXOS's comments do not include a statement supporting the introduction of EVFS at 94 GHz. Instead, it focuses only on broadening the definition of EFVS.

prospective frequency bands for such UAS operations based on a clear technical foundation, something which neither AiRXOS nor any other commenter provides.

In conclusion, if the Commission adopts an allocation at 94 GHz to enable EVFS, any service rules should promote efficient use of the spectrum, require channel selection flexibility over the entire band, and mandate compatibility with other operations in the band, including FOD detection. The Commission should not at this time consider operation in the band of EFVS-like systems by UAS. Moog looks forward, as needed, to continue to work with SNC and other stakeholders with an interest in EFVS operations in the 94 GHz band.

Respectfully submitted,

MOOG, INC.



Paul Revell
Managing Director
MOOG FERNAU LTD.
Airport Executive Park
Luton
Beds LU2 9NY
United Kingdom

Edward A. Yorkgitis, Jr.
KELLEY DRYE & WARREN, LLP
3050 K Street, NW
Suite 400
Washington, DC 20007
(202) 342-8420

Its Counsel

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